Some notes on the Life History of the Aspidomorpha Miliaris.

By Captain C. F. Bishop, R.G.A.

This is a medium sized beetle a little less than half an inch in length and breadth, of orange colour marked with black spots.

In the classification of the Cambridge Natural History it belongs to:—Order Coleoptera, Sub-Order Phytophaga, Family Chrysomelidae, Subfamily Cryptostomes, Group Cassidides.

Description.

Its head and neck are protected by a chitinous shield, which encircles the neck, and beneath which the head can be entirely withdrawn. The thorax and abdomen are entirely covered by strong chitinous elytra, which fit closely along the margin of the head shield, and together with it form a more or less hemispherical covering.

The head shield is semi-transparent and has no black spots on it. The portions of the elytra that cover the thorax and abdomen are of a dull whitish colour which changes to a bright orange as the insect grows older, and these inner portions are each ornamented with, as a rule, eight small black spots, (Fig. 4), (some specimens have only six spots), while the outer rims of the elytra, which are semi-transparent, have each two somewhat larger black spots, and a thin edging of black. The male and female are almost indistinguishable having no difference in their markings, but the female is, as a rule, slightly larger than the male.

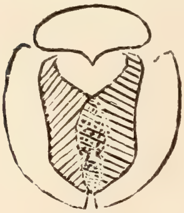
The largest specimen yet seen by the writer measured 12·5 mm. from front of head shield to the extremity of elytra, and 11·5 mm. across the widest portion of the elytra; the width of the abdomen being 6 mm. This was a female.

The smallest perfect specimen measured 9·5 mm. by 8·5 mm. breadth of abdomen being 4 mm. This was a male.

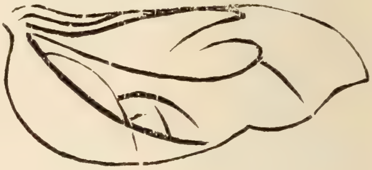
The largest males are however larger than the smallest females.

The antennae, length from 3 to 3·5 mm. consist of eleven segments. The first segment, fitting into the head between the eyes with a ball and socket joint, is a long and thick one, the second small, almost spherical; the next four are short and thick, the remaining five rather thicker and covered with fine hairs, the last being long and pointed.

The last four segments of the flagellum are coloured black, all the other segments being transparent.



(*a*)



(*b*)

The wings of the insect have two main folds when lying shut against the slightly convex dorsal surface of the abdomen, one fold running from the apex to nearly the centre of the posterior margin, the other fold across from about a third of the anterior margin from the apex almost parallel to the posterior fold. Each main fold has a fan-like fold in it, before turning under the other portion of the wing.

The veins of the wing are strongly marked, all lying within that portion of the wing which lies flat on the abdomen.

The diagrams above (not to scale) show (*a*) the positions of the wings lying flat on the abdomen, and (*b*) one wing extended, with its venation.

Larva.

The eggs from which the larvae hatch out, are laid in bunches. The size of each egg is about 2 mm. long, and ·6 mm. in greatest diameter.

The larvae are, at first, of a uniform light greenish yellow colour, semi-transparent so that when seen under the microscope by transmitted light, their internal organs appear as dark patches of varying size and shape. (Fig. 1).

They are very active, but if the proper food be near, they as a rule settle down in a flock together, and only move on as the surface of the leaf is eaten.

For the first few days of life they only eat half through the leaf, but as they grow larger they eat all but the largest veins.

The only food as yet found acceptable to them, though several have been tried, is the leaves of the *Ipomea carnea* (Woodrow), *I. superbiens* (Ferminger).

The larva, (Figs. 1 & 2) is oval in shape, with six legs, and has 32 processes projecting in all directions from the circumference of its body. These processes are furnished with spines, and vary slightly on each successive larval skin. In the youngest forms they are of unequal lengths, and longer in proportion to the size of the body, while in the later forms, they become more regular in size and shorter in proportion.

In addition to these the larva has a forked process projecting from the dorsal surface of the abdomen, which in the young forms is very long and slender, and in all forms slightly longer than the lateral processes.

This forked process by means of which the Cassidides are commonly said to cover themselves with a shelter or sunshade of excrement, is not much used in that manner by this species. The process is used in throwing off each old larval skin, during which proceeding the skin is often retained on the process for a considerable time, but the larvae almost invariably obtain shelter from the sun and rain by remaining on the under surface of the leaf they are living on, and the forked process is, as often as not, quite clean.

Larvae take from 18 to 21 days to arrive at maturity and stop feeding, during which time they shed their skins some 5 or 6 times, increasing in size and developing black marks on the dorsal surface of the abdomen. They then attach themselves to a leaf by a false foot dropped from the abdomen behind the legs, and this state lasts approximately 48 hours, after which the pupa emerges from the last larval skin but does not separate from it, the skin being retained at the extremity of the abdomen, as the connection between the pupa and the leaf, on which it remains stationary.

Pupa.

The pupa stage (Fig. 3) lasts from 4 to 5 days, as a rule, though some few exceptions remain as long as 7 days and yet eventually turn into the fully developed imago.

During the pupa stage no external changes take place, except that on the ventral surface the limbs of the insect may be observed developing.

Imago.

The imago when it is ready to burst forth from the pupa, begins to stretch and strain until it breaks the pupa skin near its head. It then pushes out its head and chitinous head shield until it can release its antennae and front pair of legs.

The elytra may then be observed to be quite soft, folded closely around the thorax and abdomen, and as it emerges from the pupa skin the elytra gradually spread out, while at the same time the insect pulls out its second and third pairs of legs.

Until the actual process of emergence has been closely watched, it is hard to realize how so large an insect can have come out of so small a pupa case.

The imago is at first of a clear yellow colour without a spot visible on it. The black spots appear in about an hour, but if the insect be observed under a microscope the positions of the spots which are to come are found to be marked by pores in the elytra which have a speck of black pigment visible. There are some 15 or 16 of these pores to each black spot.

About half an hour after emerging from the pupa the insect unfolds its wings so that the ends emerge beyond the elytra, but it does not, at this stage, attempt to fly, or even to open its elytra which are still quite soft and liable to be creased and deformed.

At this stage also, if laid on its back, the insect is incapable of turning over, unless it can reach something to hold on to with its feet, the elytra not being strong enough to aid it in turning over. The elytra harden in about a week or ten days, but the insect takes considerably longer to reach maturity.

Habits.

Females about the end of their fourth week of life, begin to lay egg bunches, even though they have been kept quite separate from the male. These eggs are unfertile.

About the same time, or perhaps a little sooner, the males begin to try to copulate.

When both male and female have fully reached maturity they breed fairly rapidly.

They appear, as a rule, to copulate in the heat of the day, never being observed *in coitu* before 9:30 or 10:0 a.m., and seldom before noon.

They remain *in coitu* for several hours, almost invariably till after 10:0 p.m.; the longest time observed being from 10:30 a.m., till 10:30 p.m., but the time of separation was not then observed.

This occurs perhaps for several successive days, then, as a rule, no copulation takes place for some 24 hours, after which the female lays an egg bunch.

Copulation again begins within 5 or 6 hours of the egg bunch being completed.

This excessive copulation observed to be the rule with almost all pairs kept in captivity by themselves, may not be so prevalent in a state of freedom if the females are more numerous than the males, especially as it appears to be quite unnecessary.

The female is provided with a spermatheca which is fertilized by the male, so enabling her to lay several fertile egg bunches after complete separation from the male.

A female isolated on the 2nd June laid egg bunches on 6th, 9th, 13th, and 15th June, all of which contained fertile eggs which hatched out in due course.

A female isolated on 23rd May, laid egg bunches on 26th and 30th May, 2nd, 4th, 8th, and 11th June, all of which hatched out.

Egg Laying.

The eggs are laid in bunches of variable sizes, usually containing from 30 to 50 eggs, but as the female grows old the bunches often decrease in size, some only containing about 10 eggs.

The method of procedure is as follows:—Starting with her abdomen depressed on to the surface on which she is standing, the insect raises a concave vertical shield of chitin exuding it from her cloaca as she raises her abdomen. This is repeated 3 or 4 times, each shield adhering to the last and overlapping it slightly to one side or the other. The abdomen is then raised and an egg exuded from the ovipositor which directs the egg into its proper vertical position as the abdomen is again lowered.

After each egg is laid another sheet of chitin is erected as a covering.

The eggs are laid in four rows, not in succession from one side to the other, but always in the same order throughout the laying.

The rate of laying is from 1 to 2 minutes for each egg, made up as follows:—

Depositing egg	10	to	20	seconds
Covering with chitin	40	to	80	seconds
Interval before next egg	10	to	20	seconds

Having deposited the last egg, two or three layers of chitin complete the egg bunch, which is normally a compact mass measuring about 5 mm. by 4 mm. in transverse section, and from 4 to 7 mm. long.

The time occupied in laying a normal egg bunch varies from 40 minutes to 1½ hours.

Egg bunches take from 10 to 13 days to hatch out.

The number of egg bunches laid by one female varies considerably. Many of the pairs of insects kept, during captivity, in Petri capsules either died after a few days, escaped when their food was being changed, or were killed for dissection and study of their anatomy. The following are a few examples of the number of egg bunches laid by females which lived for two or three weeks:—

A female kept for	39	days, laid	13	egg bunches in that time.
do.	18	do.	3	do.
do.	18	do.	3	do.
do.	28	do.	11	do.
do.	20	do.	7	do.
do.	25	do.	6	do.
do.	28	do.	8	do.
do.	16	do.	5	do.

Shewing an average of one egg bunch every 3½ days.

The longest lived of any of the insects kept in captivity was a female, which lived for 110 days, during which time she was twice paired, and laid 23 egg bunches in 75 days.

An exceptional pair, both of which died after being kept for 12 days, were observed *in coitu* for 9 consecutive days, but no egg bunch was ever laid.

An experiment of confining together 3 males and 3 females, distinguished by paint marks of different colours, shewed that they paired indiscriminately, and as freely as when kept by separate pairs.

Mortality.

After keeping the insects in captivity for about 5 months some 60 or 70 were put out free upon four small bushes of *Ipomea carnea*, and observed for the next 7 months.

Their habits as noted when kept in captivity, appear to be much the same when living in a state of freedom, though owing to their moving from one bush to another, and to the impossibility of distinguishing individuals, no very accurate observation could be made.

From the numbers of egg bunches found on the leaves it would appear that they breed at the same rate when either free or in captivity; the great difference between the two states being in the mortality during the larval stages of life.

During the earliest attempts at rearing the insects from the eggs, a very high rate of mortality was found to be the general rule. Egg bunches kept in a moist condition and exposed to the sun by day failed to hatch out at all. Young larvae similarly exposed to too great heat or moisture often lost 80 or 90 per cent of their numbers in the course of 24 hours. Young larvae if left too near to water at night, were frequently found with 50 per cent of their numbers drowned the next morning.

Consequently out of a great many egg bunches, which hatched out an average of 30 to 40 larvae each, it was frequently the case that no more than 5 or 6 per cent reached the stage of pupa.

This very high rate of mortality was found to be, to a considerable extent, avoidable with extra care, the eggs being kept in well corked specimen tubes until they hatched out, the very young larvae being kept completely isolated from ants, with but little moisture, and plenty of shade.

Yet even when better methods of preserving them were practised, the mortality among young larvae was still, in most cases, as high as 30 or 40 per cent, apparently from natural causes, variations in weather, or in the quality of the food.

There is a considerable mortality too during the changes from larva to pupa, and from pupa to imago, in the free state as well as when in captivity; the following instances were noted:—

During the change from larva to pupa:—

Out of	20	larvae	4	died
do.	5	do.	3	do.
do.	12	do.	1	do.
do.	20	do.	2	do.
do.	37	do.	1	do.
do.	41	do.	1	do.

Average nearly 9 per cent.

During the change from pupa to imago :—

Out of	16	pupa	4	died
do.	11	do.	6	do.
do.	18	do.	0	do.
do.	36	do.	2	do.
do.	23	do.	0	do.
do.	40	do.	3	do.

Average over 10 per cent.

The mortality when living in freedom is very much greater than under artificial conditions, even when care is exercised.

The *Euchromia orientalis* lays its eggs on the Ipomea carnea, and the larvae of this insect are most voracious feeders, so that the egg bunches of the *Aspidomorpha* often get so isolated by the leaf around them being eaten away, that the young larvae when they hatch out, stand but little chance of ever reaching food.

Egg bunches are sometimes found with the eggs destroyed and occupied by the pupa of a small parasitic Hymenoptera of the Family Proctotrypidae. This insect penetrating the chitinous covering of the Aspidomorpha's egg bunches, lays its eggs in the bunch.

Rain storms, when windy weather exposes the under surface of the leaves, wash off whole colonies of young *Aspidomorpha* larvae.

Probably many larvae are destroyed by birds, though no actual instances of this have yet come under the obervation of the writer.

Of 60 or 70 insects put out to live in freedom, at first a good many disappeared. For some months afterwards the numbers gradually increased, but owing to the Ipomea bushes being very small, their growth was not able to keep pace with the destruction of their leaves, and after 7 months the total number of *Aspidomorpha* remaining had decreased to between 40 and 50, with a fair proportion of egg bunches, but very few larvae or pupæ.

ASPIDOMORPHA MILIARIS.

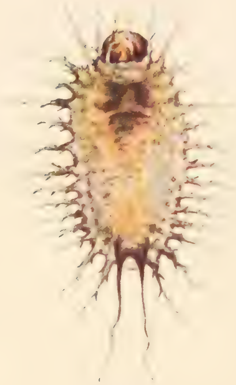


FIG. 1.

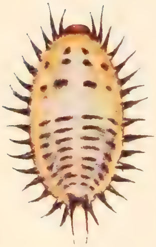


FIG. 2.

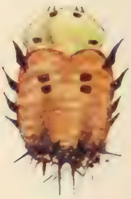


FIG. 3.

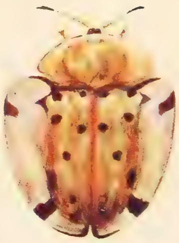


FIG. 4.

Fig. 1. Very young larva. × 17.
Fig. 2. Older larva (3rd week.) × 2½.
Fig. 3. Pupa. × 2.
Fig. 4. Adult insect. × 2.